BUILDING A NETWORK-CENTRIC WARFARE ARCHITECTURE

EXECUTIVE SUMMARY

The United States military is embracing network-centric warfare as it transforms from an industrial, Cold War structure to a 21st-century warfighting force. Network-centric warfare is a concept that was derived from analyzing order-of-magnitude improvements in effectiveness by corporations such as Wal-Mart, and law enforcement agencies like the New York City Police Department, through the use of networked information technology. This concept has seen early success in the war on terrorism, and is changing warfighting doctrine, tactics and force structure in ways not seen since the early days of World War II.

Interoperability, connectivity and network-centric systems are critical elements to field a globally deployed, near-real time force posture. The government is adopting recognized industry standards and creating segmented technology architectures to realize the much higher levels of flexibility, performance, security and connectivity needed in 21st-century systems. The acquisition process itself is changing, because of the clear need to deploy systems now, and refine as they are used, rather than taking years to define requirements and build and test an operational system.

Oracle Corporation has been a leader in helping corporations build global, network-centric enterprises to compete effectively in the 21st century, and stands ready to address many of the challenges that the military faces in transforming to an information-based warfighting infrastructure.

INTRODUCTION

Secretary of Defense Donald Rumsfeld has been driving the United States military to transform itself from a post-Cold War fighting force to one that is capable of addressing emerging 21st-century challenges. A key part of this transformation is leveraging "network-centric warfare", or the synergies derived from interoperable, connected information systems.

We've seen a glimpse of what is possible during the recent Afghanistan campaign, when American special forces soldiers were on the ground, on horseback, using laptops or PDAs to send latitude/longitude information to orbiting aircraft, which then launched precision-guided munitions to defeat Taliban armor and artillery. This early example of network-centric warfare enabled the United States to defeat the ruling regime of a country that was perceived to be unconquerable—with fewer than one-tenth the force structure required in Desert Storm—in less than two months.

This paper addresses the challenges faced by the military to build an effective network-centric warfare infrastructure and Oracle's response: a network-centric warfare architecture.

WHAT IS NETWORK-CENTRIC WARFARE?

Network-centric warfare is the term used in military circles to define information-based warfighting. Systems are interconnected in near-real time, and provide order-of-magnitude improvements in the ability to bring commander's intent and overwhelming mass to the enemy at precise points—without the logistics tail that had been required in earlier stages of warfare.

Network-centric warfare is staged in a battlespace, the three-dimensional extension of the traditional battlefield. Of paramount importance is the availability of accurate, relevant and timely data throughout a globally aware

infrastructure—a common operational picture. Sensors, platforms and operators (military forces) are all connected to share information. Forward-deployed forces can use "reachback" to get information from intelligence databases located in the United States. Air, ground and sea forces can "self-synchronize", or rapidly innovate their capabilities in new ways to address emerging combat situations. As will be explained more fully below, network-centric warfare does not eliminate the decision-making authority of the front-line combatant in favor of centralized command and control, it rather enhances the ability of the individual combat unit to see the big picture, draw on available resources, and reduce the "fog of war".

As in the business world, the effects of information technology on 21st century warfighting are revolutionary and far-reaching. War planners and strategists have been predicting radical change based on technology for some time. The current issues facing the military are how to best use information technology, how should the military's 21st century information technology infrastructure be built, and how will forces organize to make the most use of information technology while preserving the traditional "boots on the ground" advantages of forward persistence and presence.

The Origins of Network-Centric Warfare

History has been punctuated by Revolutions in Military Affairs (RMA)—major changes in warfighting brought about by technological advances. Typically the new technology incubates for more than one generation, and then military forces develop doctrine and organizational structures to gain order-of-magnitude against enemy forces.

Examples include the *stirrup*, which was used by ancient forces to allow soldiers to fight on horseback, creating an advantage in speed and mobility. At the battle of Agincourt in 1415, Henry V's forces defeated a superior French force of cavalry by using the *longbow*, a wooden spike that was planted in the ground and aimed against advancing horses. The horses screeched to a stop in front of the longbows, throwing the French knights to the ground where they were killed by the outnumbered British forces.

Mass production allowed Napoleon to draft and equip a major portion of the French male population, giving rise to the armies of nation-states instead of kingdoms, and changing the face of Europe forever. World War I saw the introduction of the tank and airplane, and the German Army was on the receiving end of early *combined arms* attacks from the French, British and American forces. By using "combined" infantry, air cover and tanks, the Allied forces were able to break through the trench-warfare stalemate that had defined the first three years of the war. During the interwar years, German officers like Heinz Guderian and Erwin Rommel refined the doctrine of combined arms that was the essence of the blitzkrieg attacks through France, Belgium and the Netherlands in May, 1940.

In 1919, Lieutenant Colonel Dwight Eisenhower led a convoy of military vehicles from Washington, DC to San Francisco over the existing cross-country road network. It took him three months. Years later, in 1945, when American forces invaded Germany, General Eisenhower noted the efficiency of the German autobahns and their ability to rapidly move equipment and people across the country. Eleven years later, President Eisenhower passed the ambitious Interstate Highway Act which, initially created to quickly evacuate American cities in the case of Soviet nuclear attack, transformed American culture by ushering in the age of the automobile and suburbs.

In the 1920s, the United States and Japanese navies defined the doctrine around launching and recovering aircraft from ships, and creating a whole new military capability at sea—*aircraft carriers* projecting seapower beyond the horizon. The ability of Japan to launch a surprise attack on Pearl Harbor, and the ability of the United States Navy to defeat the Japanese at Midway were a direct result of this doctrinal development.

In Vietnam, the US lost many aircraft over several years trying to bomb the Paul Doumer Bridge in Hanoi—a key target that was very well defended by North Vietnamese anti-aircraft forces. In 1972, the first *precision-guided munitions* were used against the bridge, and ONE aircraft was able to destroy the bridge that had defied attack for so long. In the Gulf War and Kosovo, the US was able to reduce the air strike force structure by an order of magnitude

because of the ability to deliver precision-guided munitions. In Afghanistan, the measurement for air power changed from sorties per target to targets per sortie, because the probability of hitting a specific target with a bomb rose to near 100 percent. The ability to repeatedly and precisely hit targets has significantly reduced the need for huge logistical infrastructure, numbers of aircraft (and pilots) and the political risk of having aircrew shot down behind enemy lines and used as political leverage.

Information Technology and the Military

Dr. Andrew Marshall has served as the Director of Net Assessment for the Department of Defense since 1972. He and his subordinates have been instrumental in identifying emerging warfighting technology, doctrine and organizations, and have influenced generations of senior admirals and generals who have worked with and for him. At the close of the Gulf War, a lot of debate was refereed through Dr. Marshall's office about whether the US Military was in a historical Revolution in Military Affairs due to the rise of information technology.

Among the people contributing to the debate was futurist Alvin Toffler. In his book *Powershift*, Toffler discusses the transition of power gained by holding land in the agrarian age, to holding wealth in the industrial age, to holding information in the information age. He cited Wal-Mart as an example of a company that has gained power over its suppliers through the use of information. This observation was taken by the military to identify potential transformation through the focus on information in the modern battlespace.

Vice Admiral Arthur Cebrowski, writing his seminal 1998 article on Network-Centric Warfare for the *Proceedings of the U.S. Naval Institute*, reviewed several transformational business case studies including Wal-Mart and the New York Police Department to determine their key ingredients of network-centric value creation. As the top information technology person for the Navy, then as President of the Naval War College, and now Director of the DoD Office of Force Transformation, Admiral Cebrowski has taken a lead role in defining the necessary ingredients for a network-centric military.

President George Bush and Secretary of Defense Donald Rumsfeld were advocates of transforming the military during the late 1990s. George Bush, while running for president, gave a speech in September 1999 at the Citadel, a military college in South Carolina, in which he outlined his plans for transforming the military from the 1950s Cold War model to a 21st-century information-based force. Following is an excerpt of his speech:

> *"Power is increasingly defined, not by mass or size, but by mobility and swiftness. Influence is measured in information, safety is gained in stealth, and force is projected on the long arc of precision-guided weapons. Yet today our military is still organized more for Cold War threats than for the challenges of a new century -- for industrial age operations, rather than for information age battles. Now we must shape the future with new concepts, new strategies, new resolve."*

Under Secretary of Defense Donald Rumsfeld, George Bush's strategy is being implemented, and the military's Joint Forces Command has been given the mandate to create and test systems that will work for all the services in a single campaign. The Navy's Fleet Battle Experiments, begun under Admiral Cebrowski when he was the top information officer of the Navy, have now become part of the Millennium Challenge battle experiments, of which last year's MC02 was the latest iteration—the largest joint military training and evaluation exercise in US history.

The evolving focus on network-centric warfare is giving rise to connected systems, aircrew flying over targets and communicating in real-time with planning staffs in the United States, infantry forces on the ground and ships at sea to exploit fleeting targets of opportunity. The story around NCW is just beginning!

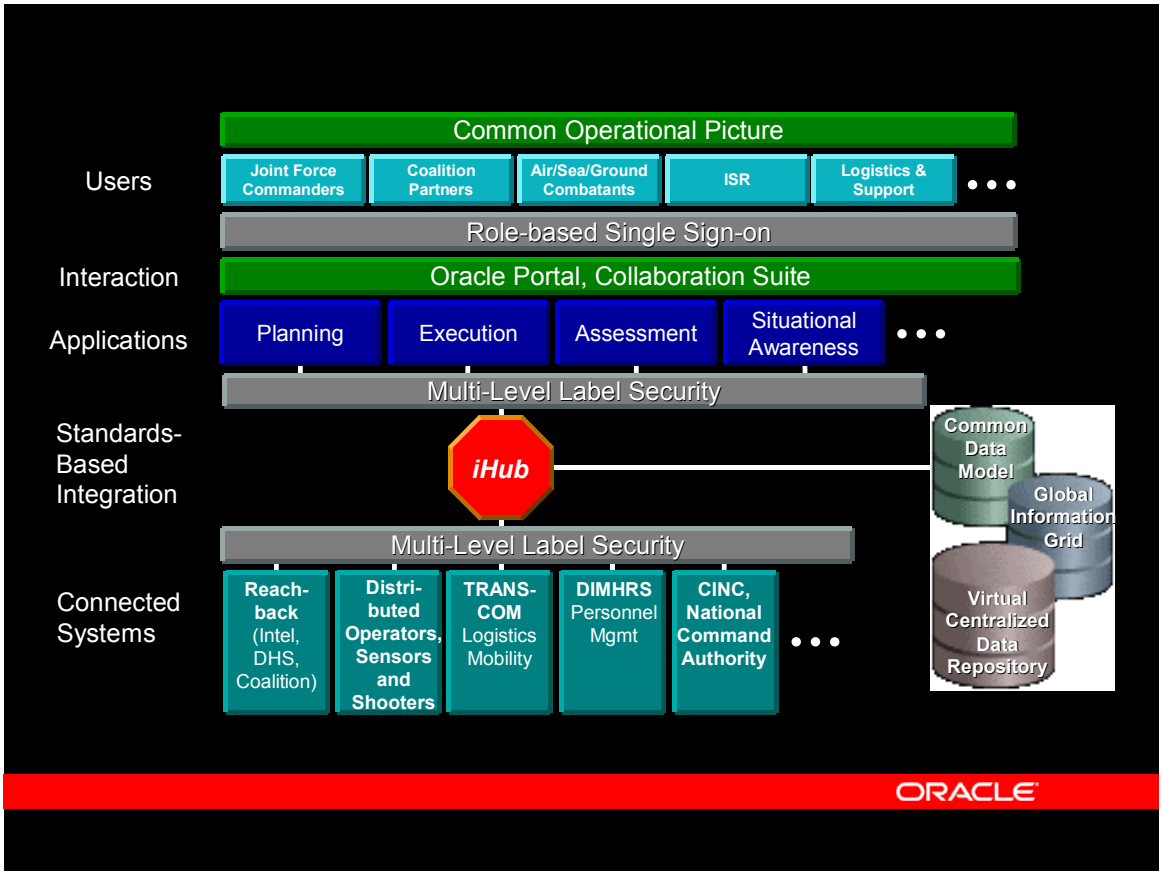
Network-Centric Warfare Visualized: Building the Common Operational Picture

The top third of the following picture shows the many different systems, platforms and forces that will connect to a network-centric warfare architecture, and the requirements for operating it, i.e, security, global deployment and communications and data management. The "system of systems" connects and interoperates to form the important "common operational picture", which is represented in the middle of the picture. Forward-deployed air, sea or ground tactical operations centers could view the same information and combine resources for rapid-targeting of enemy forces, or shape the information presentation to their own needs. Rear echelon command centers could monitor the same information to address evolving needs. The bottom third of the picture highlights several technology features that enable the network-centric warfare infrastructure. Each will be discussed in more detail in the sections below.

ORACLE'S NETWORK-CENTRIC WARFARE REFERENCE ARCHITECTURE

Admiral Cebrowski derived the network-centric warfare concept from his observations of commercial companies that used information technology to gain major competitive advantage. Oracle Corporation is a network-centric company with offices in over 100 countries that all work off of one single global instance. That means tremendous economies of scale in terms of managing the huge amounts of information that flow within and outside the company's enterprise boundaries on a daily basis. Every Oracle employee anywhere in the world can access the same information, and resources can be brought to bear much more quickly to address rapidly evolving business situations.

The following picture shows Oracle's approach to building a global, network-centric warfare architecture.



Implied in this picture are three levels of system interaction: The user level, the business level and the data level. When a system architecture is built that segments these three levels, it introduces a very high level of flexibility in terms of operating the system and evolving new capabilities.

Data Level Architecture:

The challenge most enterprises face today is that they have a hodgepodge of stovepiped legacy systems built on different architectures and data models. Interoperability is achieved only through a complicated "spaghetti" maze of point-to-point integrations, or through some type of hub and spoke enterprise application integration (EAI) model. Fusion of information from different sources is typically done manually or through a series of applications that are tailored to solving one particular kind of problem.

Data Fusion and Integration

Oracle uses an "iHub" to facilitate integration of disparate legacy systems, messaging standards and translated data models. This message-based, workflow-enabled integration hub provides a wide range of integration capabilities in a manageable format. Legacy applications can communicate directly with the hub, and new applications can be built to focus on business logic rather than integration. Applications are abstracted by the hub from the data and user layers, which minimizes the impact on the rest of the infrastructure when they are retired, replaced or modified.

Common Data Model

As the computing industry matures and enterprises evolve to common architectures and services, integration of disparate systems will become much less prevalent. By building a common enterprise data model and locating all of the services management and development frameworks at the data level, companies will be able to utilize a far greater set of compliant applications, users or registered services to meet their business needs. The data layer is not expected to change frequently, and is meant to be the foundation of the overall enterprise architecture.

Multi-Level Security and Role-Based Access

Security is managed at this level by providing directory-based access to users, networks, services and other systems, and granular labeling of data. Therefore, if a user, service, network or system wishes to access data, it must establish a profile of authorized access levels, and the enterprise can grant or limit access to data and even to search capabilities. Oracle Label Security provides granular data element-level security classifications, and solutions can be built using Oracle 9i and 9iAS features to create a very rigorous, yet flexible and maintainable multi-level security capability.

Global Data Management

Eventually, the military, and the federal government, will operate from a common data model, and network-centric operations will be conducted over a global infrastructure where network-enabled platforms will register as services onto the Global Information Grid and be able to interoperate as nodes, platforms and services in a highly connected environment. The assembly of all of these physically distributed, interconnected nodes will create a virtual global information repository that enables the reachback, speed of command and self-synchronization abilities envisioned for network-centric warfare. Oracle has very strong experience in building global information infrastructures, and saved over a billion dollars a year in operating expenses by moving to a "single global instance" infrastructure. The 9i Database contains multiple features designed to operate high-performance, highly available global information technology infrastructures.

Complex Analysis in Near-Real Time

Network-centric warfare will be conducted by taking in multiple sources of data and fusing them to create the common operational picture. Much of this information will be location-based sensor data that must be tied to intelligence information and the reports from fighting units involved in tactical engagements. Systems that provide high transaction rates, complex analysis tools and effective means of presentation to different types of users are of critical importance in this environment. Oracle provides a wealth of sophisticated data analysis tools, the high performance 9i data infrastructure to manage the transaction rates for information collection, analysis and dissemination, and the 9iAS and Collaboration Suite platforms to manage the presentation of the analyzed information. Oracle Spatial, an extended feature of the 9i database, provides the capability to manage coordinate-based or geo-referenced information.

Application Level Architecture:

Applications developed during the Cold War, be they mainframe or client-server or even early web-based ones, typically were self-contained and highly stovepiped. Any modifications to the application would typically introduce errors that made overall system management and support a very difficult task. As computing standards evolve and mature, the ability increases to create libraries of reusable business objects and to sequence workflow elements to accomplish business process flows. This provides a much more robust application development environment, because much of the "plumbing" of security, presentation, data management and integration are handled in standardized frameworks.

Rapid Prototyping and Implementation

Segmenting business logic from data and user logic allows for much more flexibility in developing applications, and drives up quality very significantly. Because development cycle times go down and quality goes up, new features can be brought on line much more quickly and less painfully than before. This allows for a higher degree of "operational experimentation", i.e., testing experimental applications, features and workflow sequences in an operational environment without taxing that environment too heavily. Also, emerging requirements can be addressed in much shorter timeframes for much lower costs. Application development becomes much like an assembly line, just pick the business logic "parts" out of the library and assemble them in the way that fits your current needs.

Oracle has a very robust set of development tools and frameworks in its 9iAS application server. These J2EE tools use the Model View Controller Framework, which is based on the Unified Modeling Language and is designed to operate in the segmented architecture discussed here. It promotes iterative, spiral development, rapid deployment and reconfiguration, and high levels of component reuse.

User Level Architecture:

In the past, each application had a built-in user interface, which required higher levels of maintenance and training because each one was different. With the rise of the World-Wide Web, organizations put "front ends" on their applications to allow people to access them over the web. Portlets then became prevalent, and allowed for dynamic rendering of information based on user actions or other contextual information.

Configurable User Interfaces

As information technology architectures mature, the user interface becomes even more separated from the underlying application, yet is based on standardized protocols. User interfaces take on the form of web pages, voice, wireless and aircraft cockpit displays. The user interface is very flexible and configurable, basically to the mission requirements and personal tastes of the end user. Oracle 9iAS provides highly configurable user interface capabilities with the Portal, single-sign on and Lightweight Directory Access Protocol, portlet design and repository management and wireless access.

Collaboration

Network-centric warfare requires a high degree of collaboration over a robust technology infrastructure. Real-time target planning, intelligence sharing, "self-synchronization" and the ability to get inside the enemy's decision loop all require users in different locations to be able to share information simultaneously. Oracle Collaboration Suite provides electronic chatrooms, virtual whiteboards and the ability to manage voice, video and data.

SOLUTION ARCHITECTURE ENGINEERING

As information technology infrastructure becomes more critical to warfighting systems, the dependence on those with expert knowledge of networked business architectures increases. General John Jumper declared the Air Operations Center a weapon system, and the current commander of the Eighth Air Force recently said that his relief would be an information operator rather than a pilot. The military must realize that its investment in weapon-class information systems will only be optimized if it also invests in the best engineering talent to maintain them.

Oracle Consulting is an organization of highly trained experts on Oracle technology. They have broad experience in the enterprise view of technology infrastructure, and employ mature and proven standards-based frameworks to manage network-centric infrastructures. Oracle Consulting paved the way in the commercial world for drastically reduced enterprise system implementation times, and has leveraged the internet for training, operations, world-wide development using offshore resources and technical support. Oracle Consulting's focus is on speed, value, and simplicity—critical attributes in the network-centric world.

Oracle's Architecture and Blueprint

Oracle Consulting offers a variety of services to work closely with its customers to assess their current technical architecture landscape and to provide guidance toward best-practice network-centric operations. A key service is the Architecture and Blueprint (A&B), an engagement that is designed to help the Oracle customer outline a technology roadmap and define sensible implementation initiatives to achieve world-class information technology capabilities. The A&B engagement has been developed to support the customer's needs to achieve high-return technology solutions. This has been necessitated by rapidly changing technology and business model transformations that require technology results in shorter time periods. The key benefits of conducting the A&B engagement include:

- Customer consensus on the implementation initiatives required to support stated business objectives and high-level business initiatives
- A documented process for completing engagement deliverables
- The leverage of Oracle's knowledge base of reference models
- A technology roadmap consistent with the organization's vision and objectives

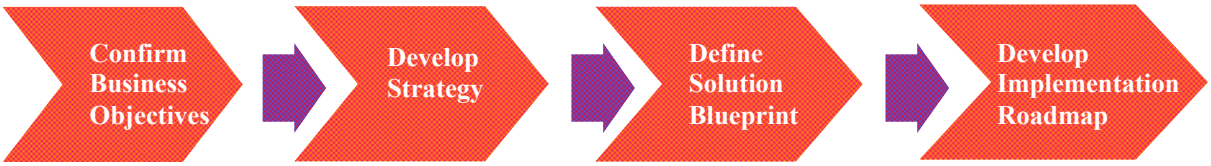
The A&B objective is to define a set of prioritized *implementation initiatives* based on the customer's business objectives and business initiatives. The implementation initiatives are defined with respect to the supporting set of requirements, solution architectures (functional and technical), and product options. The end result provides the customer with a starting point to engage in delivery of the defined implementation initiatives.

The engagement is labeled "Architecture and Blueprint" and delivers a foundation from which the customer can assess and deploy its technology platform. The output of the engagement produces a view of the organization's required technology solution in a language that includes functional and technical models, which support the stated business initiatives relative to their respective importance and priority.

The A&B engagement is generally a six to eight week effort. The scope is balanced between the breadth and depth of content undertaken and time allotted for the engagement; but it is limited to the highest priority business initiatives identified by the customer. A purely technical A&B engagement is different from the typical A&B in that its scope has been focused on IT initiatives, IT objectives, and IT requirements rather than on business initiatives. These IT

initiatives, IT objectives, and IT requirements are collected and recorded as High Level Requirements. The goal of the A&B engagement is to achieve a level of detail that supports estimating the delivery of the first iteration of implementation initiatives. The A&B engagement is structured to identify and review progress and timing with the customer at given intervals to ensure that it yields a valuable set of deliverables. If changes in approach are needed, these checkpoints will facilitate the required corrective action.

Approach



The A&B engagement is made up of four key engagement activities. These activities are mainly sequential but within each activity there are a number of activity threads (or steps) that may happen in parallel.

Activity	Description
Confirm Business Objectives	Business objectives/initiatives from either the Executive Workshop or customer are reviewed and confirmed. Minor revisions may be suggested to facilitate transition into Oracle's reference models.
Develop Strategy	Key process flows and requirements are further identified and created (using Oracle reference models). Working models of the functional and technical infrastructure are developed and initial identification of solution components are identified. Strategy is then developed to provide purpose and direction in coordinating selection and deployment of technology enablers that meet the customer's objectives.
Define Solution Blueprint	Reference models are completed to appropriate level of detail. Solution components are defined and prioritized. Initial product options are identified.
Develop Implementation Roadmap	Completed solution blueprint is translated into an implementation roadmap. The roadmap defines implementation initiatives grouped by iteration. The initial iteration is defined top down - from business objective to the requirements and technology solutions as outlined in the various deliverables developed throughout the engagement. A timeline, and high level work plan are developed to support delivery of the initial iteration of implementation initiatives.

Role

Each activity in the Architecture and Blueprint phase is highly interactive and collaborative between Oracle Consulting and the customer. A successful engagement will require the appropriate roles to be involved from both parties.

Oracle Consulting

The roles of Oracle Consulting in this engagement include one technical consultant each for Oracle9i Database and Oracle9iAS, a data strategist and a program manager. Additional roles may be utilized in an effort to address specific issues in the customer's known IT landscape, or to train new consultants in the Architecture and Blueprint process. It is assumed in this document that all roles have already been trained and certified in the Architecture and Blueprint process. Each particular step in the Architecture and Blueprint process is described including the intended Oracle roles necessary to support its completion.

Customer

Customer roles include an engagement sponsor, individuals responsible and accountable for making strategic and business decisions, business area owners, and subject matter experts.

CONCLUSION

The U. S. military is undergoing its most extensive transformation since before World War II, and is rapidly evolving from an industrial-based Cold War model to a 21st-century information-based warfighting force. Network-centric warfare is emerging as the guiding paradigm for driving this transformation and, in a reversal of roles from previous transformations, is drawing its guidance from the commercial business world. In that world, market and product lifecycles are measured in months, and change is the operative norm. Physical assets are less important than the intelligent use of *knowledge*. Companies with technology infrastructures and business practices that help them get inside the decision cycle of their competitors are at a decided advantage.

In the same way, the military has realized the need to transform as the nature of threats to the nation have dramatically changed from the symmetrical Cold War face-off against the Soviet Union. The military leadership is committed to the change, as the ability to stay inside the enemy's OODA loop becomes even more important in the shadowy fourth-generation warfare being fought by terrorists and rogue nations.

Oracle, a network-centric company, has the technology and experience to assist the military in its transformation. The 9i database, 9iAS application server, Collaboration Suite and e-Business Suite are all products used by the military that can be employed in network-centric weapon systems. Oracle Consulting provides the engineering expertise to implement, maintain and evolve these network-centric systems to meet the emerging threats of the 21st century.